Direct crowding out, optimal taxation, and pollution abatement

van der Ploeg, F.; Bovenberg, A.L.

Published in:
Economics Letters

Publication date:
1993

Economics Letters 43 (1993) 83–93

Direct crowding out, optimal taxation and pollution abatement

Frederick van der Ploeg*†

Tinbergen Institute, and CEPR, and FEE, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, Netherlands

A. Lans Bovenberg

OCFEB, Erasmus University, and CEPR, CentER, Tilburg University, Postbox 90153, 5000 LE Tilburg, and Netherlands

Received 1 June 1993
Accepted 29 June 1993

Abstract

The interactions between direct crowding out, the provision of public goods, optimal taxation, and environmental policy are explored. Greener preferences induce a larger tax rate by raising the non-distortionary level of the tax rate. If the marginal productivity of public abatement diminishes rapidly, environmental quality improves mainly through a fall in economic activity and emissions. In this case, public consumption increases which crowds out labour supply and private consumption. However, if environmental policy is very effective, public consumption falls in order to make room for public abatement. In this case, if labour supply is inelastic with respect to the after-tax wage and direct crowding in is strong, labour supply and economic activity may expand.

1. Introduction

In many countries environmental policy is high on the political agenda. Unfortunately, most of the time the debate is cast in a partial setting even though environmental policy has important implications for public finance and macroeconomics. The interaction between public finance and environmental policy is especially relevant as taxes serve the dual purpose of, on the one hand, financing a sizeable public sector, and, on the other hand, internalising environmental externalities [cf. Sandmo (1975)]. A greater concern with environmental quality ('greener' preferences) implies that the non-distortionary level of the tax rate aimed at internalising externalities (i.e. the pollution tax) rises. If the uncompensated wage elasticity of labour supply is positive, this reduces the marginal cost of public funds. In this connection, a crucial question is whether greener preferences facilitate a higher level of public consumption goods. Another important policy issue is whether the smaller distortionary level of the tax rate induced by greener preferences boosts employment. Bovenberg and van der Ploeg (1992) show that greener preferences generally induce

* Correspondence to: Frederick van der Ploeg, FEE, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, Netherlands.
† Helpful discussions with Ian Parry are gratefully acknowledged.

a drop in economic activity and employment. Moreover, a greater concern for the environment raises public consumption only if substitution between clean and dirty activities is difficult and the marginal productivity of abatement tapers off rapidly. They assume that preferences are separable in private consumption and leisure on the one hand, and public consumption and environmental quality on the other hand. Hence, public consumption does not directly crowd out private consumption and labour supply. This paper, in contrast, allows for non-separable preferences in the form of substitution between private and public consumption. It studies the implications of direct crowding out of private consumption and labour supply for optimal taxation, provision of public goods and environmental policy. In particular, we investigate under what circumstances greener preferences can yield a 'social' or an 'employment' double dividend in the sense that a cleaner environment is compatible with, respectively, a higher level of public consumption goods or a higher level of employment.

Section 2 analyses the effects of taxation and direct crowding out on labour supply and private consumption and also considers the effects on the government budget constraint. Section 3 derives optimal government policy, paying particular attention to public consumption, public abatement, the marginal cost of public funds, and the distortionary and non-distortionary levels of the tax rate. Section 4 then discusses how changes in the tax rate and the marginal cost of public funds affect public consumption, labour supply and the quality of the environment. Section 5 solves for the optimal tax rate and the marginal cost of public funds by deriving the cost and demand curves for public goods. Section 6 considers the implications of a greater preference for public consumption while section 7 studies the consequences of greener preferences. Section 8 concludes.

2. Direct crowding out of private consumption and labour supply

The representative household receives income from employment (βL), where β denotes the constant producer wage and L stands for hours worked. After-tax income ($\beta(1-t)L$), where t denotes the tax rate, must then equal private consumption (C). Households derive utility from private consumption (C), leisure ($V \equiv 1-L$), public consumption (G), and environmental quality (E). Since we focus on direct crowding out in consumption, we assume perfect substitution in utility between private and public consumption. This seems reasonable for spending on education, health care, law and order, and care for the elderly [cf. Peltzman (1973), Buiter (1977)]. We also assume that environmental quality is separable from the other components of utility, so that the utility function can be written as

$$U \equiv M(C + \gamma_G G, V) + \gamma_E E, \quad \gamma_E > 0\,, \tag{1}$$

where γ_G and γ_E denote the preference weights given to public consumption and the quality of the environment, respectively. The sub-utility function, $M(\cdot)$, is concave and weakly homothetic. Households are atomistic and thus take the wage, the tax rate, and environmental quality as given. Households thus equate the marginal rate of substitution between consumption goods and leisure to the consumer wage [i.e. $w \equiv (1-t)\beta$], so that $M_V/M_C = w$, where subscripts denote partial derivatives. Together with the household budget constraint, this yields expressions for private consumption, labour supply, and indirect private utility:

$$C = c(w, \gamma_G G), \qquad L = l(w, \gamma_G G), \qquad M = m(w, {}_{\gamma G} G)\,. \tag{2}$$

Log-linear deviations from a benchmark are denoted by a tilde (e.g. $\tilde{C} \equiv \mathrm{d}C/C$), unless indicated otherwise. Log-linearisation of (2) then yields:

$$\tilde{C} = -(1+\epsilon_w)\tilde{t} - \epsilon_G(\tilde{\gamma}_G + \tilde{G}), \qquad \tilde{L} = -\epsilon_w\tilde{t} - \epsilon_G(\tilde{\gamma}_G + \tilde{G}),$$
$$\tilde{M} = (1-\omega_V)[(1-\omega)(\tilde{\gamma}_G + \tilde{G}) - \omega\tilde{t}] \tag{2'}$$

where $\tilde{t} \equiv dt/(1-t)$, $0 < \omega \equiv C/(C+\gamma_G G) < 1$, denotes the share of private consumption in the total basket of private and public consumption, and $0 < \omega_V \equiv \omega V/(\omega V + L) < 1$. The uncompensated wage elasticity of labour supply is given by $\epsilon_w = (\sigma - \omega)\omega_V/\omega$, where σ represents the substitution elasticity between private consumption and leisure in $M(\cdot)$. A higher tax rate lowers the consumer wage and induces substitution away from consumption of goods to leisure, so that labour supply falls. However, a higher tax rate also encourages agents to work more hours in order to make up for the fall in after-tax income. If the first (substitution) effect dominates the second (income) effect, i.e. if $\sigma > \omega$, the uncompensated wage elasticity of labour supply is positive, so that a higher tax rate lowers both labour supply and the level of indirect private utility. [1]

The elasticity of labour supply with respect to the level of public consumption is given by $\epsilon_G = (1-\omega)\omega_V/\omega > 0$. Hence, a high level of public consumption depresses both private consumption and labour supply. More public provision of consumption goods reduces the need for private consumption goods and induces households to work less hours, while the level of private utility rises. This phenomenon is called direct crowding out [cf. Buiter (1977)].

It is useful to note that a higher tax rate induces substitution away from consumption goods towards leisure and thus raises the marginal private utility of private consumption:

$$\tilde{M}_C = \omega_V\tilde{t}\,. \tag{3}$$

We assume full employment. Output (i.e. $Y = \beta NL$, where N denotes the number of households) must equal total demand for products (i.e. $Y = NC + G + A$, where A denotes the level of abatement undertaken by the government). We thus assume that output is proportional to employment and that producer prices and the producer wage are fixed. Decreasing returns to scale in production do not affect the results as long as pure profits are taxed away and producer prices result from competitive behaviour [Auerbach (1985)].

Log-linearisation of the goods market equilibrium condition or, equivalently, the government budget constraint (i.e. $G + A = t\beta NL$) yields:

$$\omega_G\tilde{G} + \omega_A\tilde{A} = (1-t)\tilde{t} + t\tilde{L} = (1 - t - t\epsilon_w)\tilde{t} - t\epsilon_G(\tilde{\gamma}_G + \tilde{G}) \tag{4}$$

where $\omega_G \equiv G/Y$ and $\omega_A \equiv A/Y$ define the national income shares of public consumption and public abatement, respectively. The change in total public spending must thus equal the change in public revenues. The first term on the last right-hand side of (4) consists of a direct effect of a higher tax rate on tax revenues (i.e. $1-t$) plus an indirect effect arising from the induced change in labour supply and the tax base ($-\epsilon_w t$). Clearly, if the wage elasticity of labour supply is positive, a higher tax rate erodes the tax base. To rule out a downward-sloping Laffer curve, we assume $1 - t - t\epsilon_w > 0$. The second term on the last right-hand side of (4) stands for the erosion of the tax base and the consequent drop in tax revenues arising from the adverse effect of public consumption on labour supply. This corresponds to the negative effect of direct crowding out on the tax base and thus government revenues.

Pollution is an inevitable by-product of production, hence environmental quality worsens as the levels of production and thus emissions rise. However, environmental quality can be enhanced

[1] See Hausman (1985) for more details on taxation and labour supply.

through public abatement, albeit under decreasing returns. We assume that environmental quality is given by

$$E = e(A) - \alpha Y, \quad e' > 0,\ e'' < 0\,, \tag{5}$$

where α denotes the emission–output ratio. The appendix shows that private abatement in combination with a pollution tax yields qualitatively similar results.

3. Optimal government policy

The government maximises social welfare:

$$NU = N\{m(\beta(1-t), \gamma_G G) + \gamma_E[e(A) - \alpha\beta N l(\beta(1-t), \gamma_G G)]\} \tag{1'}$$

subject to the budget constraint $t\beta N l(\beta(1-t), \gamma_G G) = G + A$. The government has no access to lump-sum taxes and subsidies. The tax rate thus faces the dual task of, on the one hand, raising public revenues to finance public consumption and public abatement, and, on the other hand, internalising pollution externalities. Hence, we face a second-best problem in public finance.

3.1. Public consumption

The first-order condition for the level of public consumption yields:

$$N\gamma_G = \eta[1 + (t - t_N)\epsilon_G/\omega_G]\,, \tag{6}$$

where η denotes the marginal cost of public funds (i.e. the social marginal disutility of raising an extra unit of public revenue, μ, divided by the marginal utility of private consumption, M_C), and t_N stands for the non-distortionary level of the tax rate [see expression (7) in subsection 3.2]. The Samuelson rule for the optimal provision of public goods assumes that lump-sum taxes are available and states that the sum of the marginal rates of substitution between public and private consumption goods ($N\gamma_G$) should equal the marginal rate of transformation (i.e. unity). Equation (6) modifies the Samuelson rule for the presence of distortionary taxation ($t > t_N$). In particular, the price of public consumption in terms of private consumption goods [the right-hand side of (6)] can differ from the corresponding marginal rate of transformation for two reasons [cf. Atkinson and Stern (1974)]. First, the marginal cost of public funds can differ from one [see expression (9) in subsection 3.3]. Second, the fact that public consumption crowds out labour supply ($\epsilon_G > 0$) and thus depresses the base of the distortionary tax (i.e. $t - t_N > 0$) raises the relative price of public consumption above the marginal cost of public funds. [2]

An alternative interpretation of (6) is that society is more willing to pay a high marginal cost of public funds (η) if the preference for public consumption (γ_G) is high. If the tax rate (t) is high and the non-distortionary level of the tax rate (t_N) is low, the distortionary tax rate ($t - t_N$) is large. In that case, the erosion of the distortionary tax base due to direct crowding out implies a relatively large gap between, on the one hand, the price of public consumption and, on the other hand, the cost of public funds. Hence, if the distortionary tax rate is high, society is less willing to pay a high marginal cost of public funds for a given preference for public consumption. Log-linearisation of the modified Samuelson rule (6) yields:

[2] Note that the price of public consumption is unity, if the distortionary tax is zero ($t = t_N$). In that case, the marginal cost of public funds is unity [see expression (9)].

$$\tilde{\eta} = \tilde{\gamma}_G - (\eta\epsilon_G/\omega_G N\gamma_G)[(1-t)\tilde{t} - t_N\tilde{t}_N] \,, \tag{6'}$$

where we assume that changes in ϵ_G/ω_G are insignificant.

3.2. Non-distortionary level of the tax rate and public abatement

The non-distortionary level of the tax rate is defined as follows:

$$t_N \equiv N\gamma_E\alpha/\mu = (N\gamma_E\alpha/M_C)(1/\eta) \,. \tag{7}$$

The textbook Pigovian tax rate (t_P) is the sum of the marginal environmental damages of production divided by the marginal utility of private income to convert from utility units into units of production, i.e. $t_P = N\gamma_E\alpha/M_C$. The non-distortionary (or externality-correcting) level of the tax rate is the Pigovian tax rate divided by the marginal cost of public funds ($t_N = t_P/\eta$). Hence, as public funds become scarcer (higher η) the government can less afford to internalise environmental externalities and must pay more attention to the objective of raising public revenues. Making use of (3), we can log-linearise (7) as follows:

$$\tilde{t}_N = \tilde{\gamma}_E + \tilde{\alpha} - \omega_V\tilde{t} - \tilde{\eta} \,. \tag{7'}$$

The non-distortionary level of the tax rate thus increases with both the priority society attaches to a clean environment and the emission–output ratio but declines with the tax rate and the marginal cost of public funds.

The optimal level of public abatement follows from equating the social marginal utility of public abatement, $N\gamma_E e'(A)$, to the social marginal disutility of raising public revenue, μ. Making use of (7), we find that the marginal productivity of public abatement rises with the emission–output ratio and declines with the long-distortionary level of the tax rate (particularly if the productivity of public abatement does not drop off rapidly, i.e. if the elasticity $\sigma_A \equiv -Ae''(A)/e'(A) > 0$ is small):

$$e'(A) = \alpha/t_N \quad \text{or} \quad \tilde{A} = (\tilde{t}_N - \tilde{\alpha})/\sigma_A \,. \tag{8}$$

Substitution of (7′) into (8) gives

$$\tilde{A} = [\tilde{\gamma}_E - \omega_V\tilde{t} - \tilde{\eta}]/\sigma_A \,. \tag{8'}$$

Public abatement thus increases if preferences become greener or the tax rate (and the marginal utility of private income) falls. Public abatement is financed through taxation. Hence, less abatement is provided if the marginal cost of public funds rises.

3.3. The tax rate and the marginal cost of public funds

The first-order condition for the optimal tax rate is

$$-N\beta m_w + N\gamma_E\alpha\beta^2 N l_w = -\mu\beta NL + \mu t\beta^2 N l_w \,.$$

Dividing by $-N\beta LM_C$ and making use of Roy's identity (i.e. $m_w = LM_C$) and $\epsilon_w \equiv w l_w/L$ yields the following expression for the marginal cost of public funds:

$$\eta \equiv \mu/M_C = [1 - ((t - t_N)/(1-t))\epsilon_w]^{-1} \,. \tag{9}$$

We assume that changes in the wage elasticity of labour supply are small and insignificant ($\tilde{\epsilon}_w = 0$). Accordingly, log-linearisation of (9) yields:

$$\tilde{\eta} = [\eta\epsilon_w/(1-t)][(1-t_N)\tilde{t} - t_N\tilde{t}_N] \,. \tag{9'}$$

If the uncompensated wage elasticity of labour supply is positive ($\epsilon_w > 0$, $\sigma > \omega$) and the tax rate exceeds its non-distortionary level ($t > t_N$), the marginal cost of public funds exceeds the marginal rate of transformation between public and private consumption (i.e. unity). A higher tax rate or a lower non-distortionary level of the tax rate (i.e. a higher distortionary tax rate, $t - t_N$) magnifies the deadweight losses of taxation and raises the marginal cost of public funds if the labour supply curve slopes upwards ($\epsilon_w > 0$). If substitution and income effects of higher consumer wages on labour supply cancel out ($\sigma = \omega$), the marginal cost of public funds coincides with the marginal rate of transformation between public and private consumption. In that case, a labour tax acts as a lump-sum tax.

4. Public consumption, labour supply and environmental quality

This section expresses government consumption, employment, and environmental quality in terms of the tax rate and the marginal cost of public funds. Substituting (8′) into the government budget constraint (4) and solving for the change in public consumption, we obtain:

$$(\omega_G + t\epsilon_G)\tilde{G} = [1 - t - \epsilon_w t + (\omega_A/\sigma_A)\omega_V]\tilde{t} + (\omega_A/\sigma_A)(\tilde{\eta} - \tilde{\gamma}_E) - t\epsilon_G\tilde{\gamma}_G \,. \tag{10}$$

Upon substitution of (10) into (2′), we obtain the change in labour supply:

$$\tilde{L} = -[\epsilon_G/(\omega_G + t\epsilon_G)]\{[1 - t + \epsilon_w(\omega_G/\epsilon_G) + (\omega_A/\sigma_A)\omega_V]\tilde{t} + (\omega_A/\sigma_A)(\tilde{\eta} - \tilde{\gamma}_E) + \omega_G\tilde{\gamma}_G\} \,. \tag{11}$$

Equations (10) and (11) can be interpreted as follows. A higher tax rate raises the level of public consumption, directly, and also because it makes environmental policy less ambitious by depressing the level of public abatement [cf. (8′)]. A higher tax rate reduces labour supply directly if the substitution effect dominates the income effect (i.e. $\sigma > \omega$), but also indirectly due to direct crowding out. A higher marginal cost of public funds or a smaller priority to environmental quality makes environmental policy less ambitious by reducing public abatement, thereby creating more room for public consumption. The reallocation away from private consumption to public consumption crowds out labour supply and thus reduces both output and emissions. A higher priority for public consumption induces direct crowding out and thus reduces labour supply.

Using (2′), (7) and (8), we can write the change in environmental quality as

$$\alpha_E\tilde{E} = \omega_A\tilde{A} - t_N[\tilde{\alpha} - \epsilon_w\tilde{t} - \epsilon_G(\tilde{\gamma}_G + \tilde{G})] \,, \tag{12}$$

where $\alpha_E \equiv t_N E/\alpha Y$ denotes the social value of environmental quality in terms of national income. Environmental quality improves if public abatement rises or the emission–output ratio falls. The environment also improves if the value of public consumption rises, i.e. if direct crowding out depresses labour supply and economic activity. If the wage elasticity of labour supply is positive, a higher tax rate depresses labour supply, output, and emissions and thus improves the quality of the environment as well. Substitution of (8′) and (10) into (12) yields:

$$\alpha_E \tilde{E} = -t_N \tilde{\alpha} + [(\omega_A/\sigma_A)(\omega_G + (t - t_N)\epsilon_G)/(\omega_G + t\epsilon_G)](\tilde{\gamma}_E - \tilde{\eta}) + [t_N \epsilon_G \omega_G/(\omega_G + t\epsilon_G)]\tilde{\gamma}_G$$
$$+\{[\epsilon_G t_N(1 - t + \epsilon_w \omega_G/\epsilon_G) - (\omega_A/\sigma_A)\omega_V \omega_G]/(\omega_G + t\epsilon_G)\}\tilde{t}\,. \qquad (12')$$

The effect of a higher tax rate on environmental quality is ambiguous. If the fall in public abatement is large (i.e. if σ_A is small), direct crowding out is weak, and the substitution elasticity between leisure and commodities (σ) is small, so that the fall in output and emissions is small (ϵ_G and ϵ_w are small), environmental quality deteriorates, otherwise the environment improves. A higher priority for public consumption depresses economic activity and emissions and thus improves the quality of the environment.

5. Cost and demand for public goods

This section solves for the optimal tax rate and the marginal cost of public funds. Substituting (7′) into (9′), using (9), and solving for $\tilde{\eta}$ gives the cost curve (see Fig. 1):

$$\tilde{\eta} = [\epsilon_w/(1 - t - \epsilon_w t)][(1 - t_N(1 - \omega_V))\tilde{t} - t_N(\tilde{\gamma}_E + \tilde{\alpha})]\,. \qquad (9'')$$

A higher national income share of public spending raises the distortionary tax rate (i.e. the wedge between the actual and the non-distortionary level of the tax rate), both directly as the overall tax rate (t) is higher and indirectly as it reduces the non-distortionary level of the tax rate [see (7′)]. If the uncompensated wage elasticity of labour supply is positive ($\sigma > \omega$), the marginal cost of public funds rises with the distortionary tax rate and thus the size of the public sector [see (9′)]. A greater concern for environmental quality ($\tilde{\gamma}_E > 0$) or a higher emission–output ratio ($\tilde{\alpha} > 0$) raises the non-distortionary level of the tax rate and thus shifts down the cost curve if the labour supply curve slopes upwards. Note that a zero wage elasticity of labour supply ($\sigma = \omega$) corresponds to a flat cost curve ($\tilde{\eta} = 0$ as $\eta = 1$).

Substitution of (7′) into the modified Samuelson rule (6′) yields the demand curve for public consumption (also see Fig. 1):

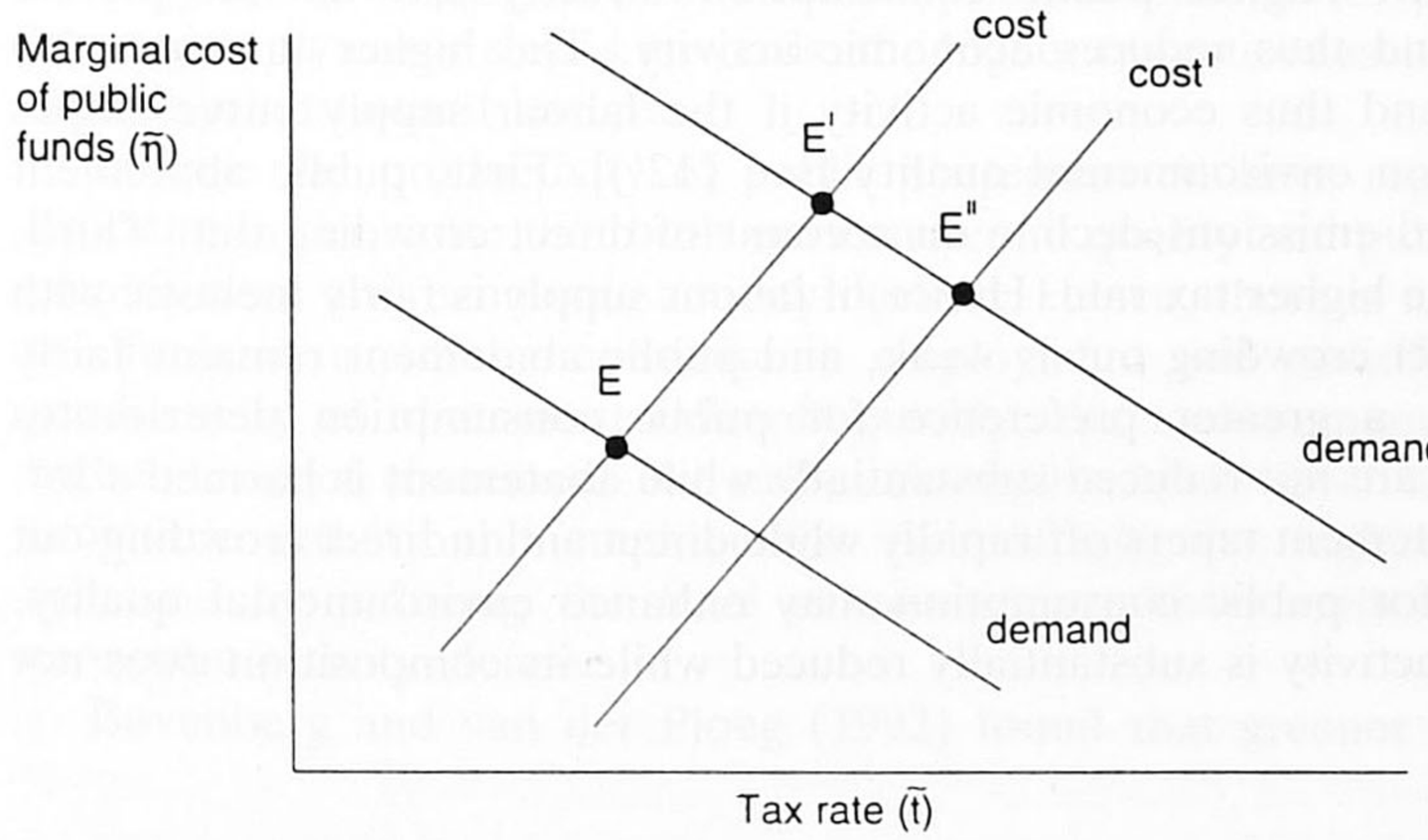

Fig. 1. Cost and demand for public goods. *Key*: A greater preference for public consumption causes a shift from E to E'. Greener preferences or a higher emission output ratio shifts E to E''. *Note*: The figure assumes a positive wage elasticity of labour supply, else the cost curve slopes downwards.

$$\tilde{\eta} = [\tilde{\gamma}_G + \epsilon_{GG} t_N(\tilde{\gamma}_E + \tilde{\alpha}) - \epsilon_{GG}(1 - t + t_N \omega_V)\tilde{t}]/(1 + \epsilon_{GG} t_N)\,, \tag{6''}$$

where $\epsilon_{GG} \equiv \eta \epsilon_G / \omega_G N \gamma_G > 0$. Society is willing to pay a higher marginal cost of public funds if the preference for public consumption rises. To the extent that direct crowding out occurs, the cost of public funds rises with a lower tax rate, a higher emission–output ratio, and greener preferences. Effectively, a more ambitious environmental policy raises the non-distortionary level of the tax rate. This reduces the wedge (due to direct crowding out) between the price of public consumption [see (6)] and the cost of public funds. In general, the demand curve slopes downwards and shifts out when there is an increase in the priority given to environmental quality (γ_E), the preference for public consumption (γ_G), or the emission–output ratio (α). The special case of no direct crowding out ($\epsilon_{GG} = 0$) corresponds to a flat demand curve ($\tilde{\eta} = \tilde{\gamma}_G$).

Intersection of the cost curve and the demand curve [i.e. solving (6″) and (9″)] yields expressions for the optimal changes in the tax rate and the marginal cost of public funds:

$$\Delta \tilde{t} = \eta(1 - t - \epsilon_w t)\tilde{\gamma}_G + [\epsilon_{GG}(1 - t) + \eta \epsilon_w] t_N(\tilde{\gamma}_E + \tilde{\alpha})\,, \tag{13}$$

$$\Delta \tilde{\eta} = \nu \epsilon_w [1 - t_N(1 - \omega_V)]\tilde{\gamma}_G + \epsilon_{GG}(t - t_N)\eta t_N \epsilon_w(\tilde{\gamma}_E + \tilde{\alpha})\,, \tag{14}$$

where $\Delta \equiv \eta \epsilon_w [1 + t_N(\omega_V + (t - t_N)\epsilon_{GG})] + \epsilon_{GG}(1 - t)(1 - t + t_N \omega_V) > 0$. [3]

6. A greater preference for public consumption goods

A greater preference for public consumption goods ($\tilde{\gamma}_G > 0$) leaves the cost curve unaffected, but shifts the demand curve out. The equilibrium shifts from $\boldsymbol{E}$ to $\boldsymbol{E}'$, so that the tax rate rises and, if the wage elasticity of labour supply is positive, the marginal cost of public funds rises as well [see Fig. 1 or (13) and (14)]. As a result, the government can less afford to use the tax rate to correct for pollution externalities and thus the non-distortionary level of the tax rate and the level of public abatement fall [see (7′) and (8′)]. Public consumption also rises because the tax rate and hence government revenues rise [see (10)]. Effectively, the government substitutes public consumption for public abatement. Higher public consumption directly crowds out private consumption and labour supply and thus reduces economic activity. The higher tax rate also directly depresses labour supply and thus economic activity if the labour supply curve slopes upwards. There are three effects on environmental quality [see (12′)]. First, public abatement falls. Second, economic activity and emissions decline on account of direct crowding out. Third, activity and emissions fall due to the higher tax rate. Hence, if labour supply is fairly inelastic with respect to the after-tax wage, direct crowding out is weak, and public abatement remains fairly effective (i.e. small ϵ_w, ϵ_G, σ_A), a greater preference for public consumption deteriorates environmental quality as emissions are not reduced substantially while abatement is harmed a lot. However, if the productivity of abatement tapers off rapidly while direct and indirect crowding out are significant, a higher priority for public consumption may enhance environmental quality. Intuitively, the level of economic activity is substantially reduced while its composition does not become much dirtier.

[3] A positive value of Δ is, in fact, a second-order condition for government policy. It implies that, if $\epsilon_w < 0$, the demand curve is steeper than the cost curve.

7. Consequences of greener preferences

A greater concern for environmental quality ($\tilde{\gamma}_E > 0$) shifts out both the cost curve and the demand curve, so that the equilibrium moves from E to E''. Greener preferences raise the non-distortionary level of the tax rate. This raises the overall tax rate (t) and therefore the national income share of public spending [see (13)]. Intuitively, a higher non-distortionary tax rate allows a higher overall tax rate because both the cost of public funds (9) and the impact of direct crowding out on the price of public consumption (6) depend on the gap between the overall and the non-distortionary tax rate (i.e. the distortionary tax rate, $t - t_N$). How much the tax rate rises for a given green preference shock depends on the size of the uncompensated wage elasticity of labour supply (ϵ_w) relative to the importance of direct crowding out (as indicated by ϵ_G). The expansion of the size of the public sector is largest if the uncompensated wage elasticity is small while direct crowding out is important. The reason is that a larger tax rate is less effective in offsetting the impact of a higher non-distortionary tax rate on the price of public consumption if the uncompensated wage elasticity of labour supply is small relative to the elasticity ϵ_G.

If the uncompensated wage elasticity and the distortionary tax rate are positive [i.e. $\epsilon_w(t - t_N) > 0$], the marginal cost of public funds rises as preferences become greener [see expression (14)]. In that case, the higher overall tax rate exerts a larger positive impact on the marginal cost of public funds (9) than on the price of public consumption (6). Hence, the marginal cost of public funds rises to offset the negative effect of the higher non-distortionary tax rate on the price of public consumption.[4]

The overall effect of greener preferences on the level of public consumption is ambiguous. On the one hand, the expansion of the public sector associated with the higher tax rate benefits public consumption. On the other hand, higher public abatement (8′) crowds out the other category of public spending, i.e. public consumption. Accordingly, whereas public consumption can rise on account of the positive effect on the *level* of public spending, it may fall due to the change in the *composition* of public spending toward public abatement and away from public consumption. The importance of the second effect depends on the elasticity σ_A. If the productivity of abatement tapers off quickly (i.e. a large value for σ_A), public abatement does not rise much. Hence, the level effect offsets the composition effect and public consumption rises.

If public consumption rises, employment declines for two reasons. First, direct crowding out reduces labour supply as public consumption substitutes for private consumption. Second, if the labour supply curve slopes upwards, the higher tax rate causes households to substitute away from consumption toward leisure.

In case the productivity of public abatement declines rapidly, there exists a 'social' double dividend in the sense that both environmental quality and public consumption expand. However, employment and economic activity decline. Hence, there is no 'employment' double dividend in the form of a simultaneous rise in employment and environmental quality. Intuitively, if the productivity of abatement falls off quickly, the environment improves not so much through a higher level of abatement but rather through a lower level of emissions due to a lower level of economic activity and employment. Accordingly, the higher level of environmental quality is achieved by reducing the *level* of economic activity rather than making the *composition* of economic activity cleaner.

Bovenberg and van der Ploeg (1992) found that greener preferences never expand employ-

[4] Bovenberg and van der Ploeg (1992) do not allow for direct crowding out, so that greener preferences do not affect the price of public consumption and thus reduce the marginal cost of public funds if the uncompensated wage elasticity of labour supply is positive.

ment. However, they abstracted from direct crowding out by assuming that public consumption was separable from private consumption in social utility. This paper, in contrast, finds that more concern for the environment may boost employment if private and public consumption are close substitutes so that direct crowding out occurs. In particular, for employment to rise, two conditions must be met. First, the productivity of abatement must drop off only slowly (small σ_A). This ensures that public consumption falls to make room for more public abatement. Second, the effect of direct crowding out on labour supply (i.e. ϵ_G) should be large relative to the uncompensated wage elasticity of labour supply (ϵ_w). In that case, the positive labour-supply effect of lower public consumption dominates the negative labour-supply effect associated with a higher overall tax rate.

The possibility of a rise in employment in response to greener preferences can be interpreted as follows. More concern for the environment induces substitution away from the public good of ordinary public consumption, which is a perfect substitute for private consumption, toward the public good of the environment, which is separable from private consumption. Hence, private consumption, and hence labour supply, rise to make up for the lower provision of public goods that are substitutes for private consumption (i.e. public consumption).

The first condition for an 'employment' double dividend reveals that the 'employment' and 'social' double dividends exclude each other. In particular, the 'employment' double dividend requires a decline in public consumption. Intuitively, direct crowding out boosts employment only if public consumption declines. A 'social' double dividend requires a decline in employment. In this case, public abatement does not rise much, thereby allowing room for expanding public consumption. This implies that environmental quality cannot improve much through public abatement. Hence, a better environmental quality has to be achieved mainly by reducing the level of employment and output, thereby cutting emissions. The 'social' double dividend is thus compatible with the *pessimistic* view, which argues that a higher environmental quality requires a lower level of economic activity. The 'employment' double dividend, in contrast, is consistent with the *optimistic* view, which says that a higher level of economic activity is compatible with a better quality of the environment. Under the optimistic view, the environment is enhanced through a cleaner composition of economic activity (i.e. a higher level of abatement) rather than a lower level of that activity. In fact, the level of employment and activity may rise.

It is also possible that neither an 'employment' nor a 'social' double dividend occurs. This is the case if direct crowding out is weak and at the same time the productivity of public abatement does not fall rapidly (i.e. both ϵ_G and σ_A are small). In this scenario, environmental quality improves through both a lower level of economic activity and a higher level of public abatement.

8. Conclusion

A greater concern for the environment implies a higher non-distortionary level of the tax rate. This allows for a higher tax rate, thereby boosting public spending. If the productivity of abatement declines rapidly, the additional revenues are used mainly for public consumption. Environmental quality must then improve mostly through a lower level of production and emissions rather than through a higher level of abatement. Under this scenario labour supply and private consumption fall due to both a higher level of public consumption (i.e. direct crowding out) and substitution towards leisure on account of a lower consumer wage. Conventional environmental policy in the form of public abatement is thus aided by direct crowding out. However, if public abatement remains very effective, the additional public revenues are used for public abatement rather than for public consumption. In fact, in this latter case, public

consumption may fall in order to create room for public abatement in which case direct crowding in attenuates the fall in labour supply and the level of economic activity. Hence, public abatement is hampered by the adverse effect of crowding in on environmental quality.

If the wage elasticity of labour supply is small, the effects of direct crowding in are strong, and the productivity of public abatement does not taper off quickly, the 'employment' double dividend hypothesis, i.e. greener preferences boost both environmental quality and the level of employment, can be given support, albeit at the expense of a lower level of public consumption (i.e. no 'social' double dividend).

Appendix: Private abatement and pollution taxes

Here we briefly provide an alternative specification of our model. Let A stand for private rather than public abatement, and let t_N denote an explicit pollution tax rate. Also, let t_L stand for an employers' rather than an employees' tax rate. In that case, profits of firms are given by

$$\pi \equiv \beta NL - w(1+t_L)NL - A - t_N[\alpha Y - e(A)] ,$$

where w denotes the wage paid to workers (i.e. the consumer wage) and $w(1+t_L)$ is the cost per unit of labour (i.e. the producer wage). Maximisation of profits yields:

$$w = \beta(1-t_N\alpha)/(1+tL) \quad \text{and} \quad e'(A) = 1/t_N .$$

Hence, profits are given by

$$\pi = [(e(A)/A) - e'(A)]t_N A .$$

The household budget constraint is $wL + (\pi/N) = C$ and the government budget constraint gives $G = t_L wNL + t_N[\alpha Y - e(A)]$. It is straightforward to demonstrate that this alternative specification yields the same results for the levels of abatement (A), public consumption (G), and private consumption (NC). The main difference compared with the case with public abatement is that the *observed* tax rate on labour (t_L) is lower than the tax rate with public abatement (t) as clean-up activities occur in the private sector. Greener preferences now induce a fall in the size of the public sector as measured by actual tax collections if the productivity of public abatement does not diminish too quickly.

References

Atkinson, A.B. and N.H. Stern, 1974, Pigou, taxation and public goods, Review of Economic Studies 41, no. 1, 119–128.
Auerbach, A.J., 1985, The theory of excess burden and optimal taxation, in: A.J. Auerbach and M. Feldstein, eds, Handbook of public economics, vol. I (North-Holland, Amsterdam) 61–127.
Bovenberg, A.L. and F. van der Ploeg, 1992, Environmental policy, public finance and the labour market in a second-best world, Discussion paper 745, CEPR, London.
Buiter, W.H., 1977, 'Crowding out' and the effectiveness of fiscal policy, Journal of Public Economics 7, 309–328.
Hausman, J.A., 1985, Taxes and labor supply, in: A.J. Auerbach and M. Feldstein, eds., Handbook of public economics, vol. I (North-Holland, Amsterdam) 213–263.
Peltzman, S., 1973, The effect of public subsidies-in-kind on private expenditures: The case of higher education, Journal of Political Economy 81, 1–27.
Sandmo, A., 1975, Optimal taxation in the presence of externalities, Swedish Journal of Economics 77, 86–98.